MULTIMEDIA UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

EMF4076 –ELECTROMAGNETIC INTERFERENCE
(EE& TE)

1st MARCH 2019
3:00 P.M. – 5:00 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Briefly explain the TWO aspects of Electromagnetic Compatibility (EMC): Emission and Susceptibility.

[6 marks]

(b) The equivalent circuit for inductive coupling between three parallel wires is shown in Figure Q1b. A source voltage, V_S, is connected to lead-1. R_{1S} and R_{2S} represent the source resistance for lead-1 and lead-2 respectively, R_{1L} and R_{2L} represent the load resistance for these two leads respectively. The expression for the noise voltage, V_N is given by:

$$V_N = \frac{j\omega L_{12} R_{2L} V_S}{(j\omega)^2 (L_1 L_2 - L_{12}^2) + j\omega (L_2 R_1 + L_1 R_2) + R_1 R_2}$$

(i) If V_N can be shown as below,

$$V_N = K \cdot \frac{j\omega V_S}{(j\omega + s_a)(j\omega + s_b)}$$

Obtain the expression for K, s_a, and s_b.

[3 marks]

(ii) Show the frequency response of V_N at low-frequency end, at high-frequency end, and at mid-frequency range.

[4 + 4 + 4 marks]

(iii) Recommend two ways to reduce inductive coupling noise at low-frequency end (refer to equation found in Q1b (ii) for low-frequency end).

[4 marks]

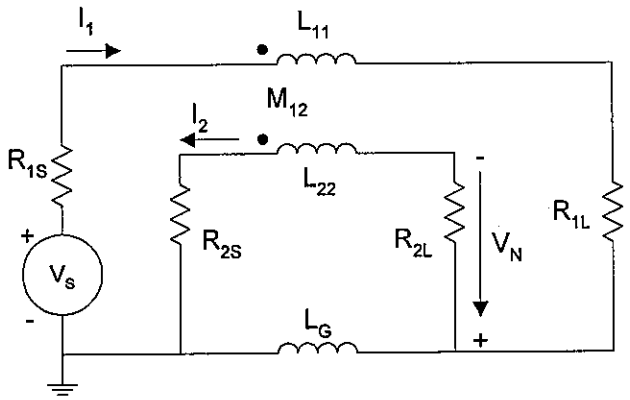

Figure Q1b

Continued . . .

Question 2

(a) With the aid of appropriate diagrams, explain the differences between single-point and multi-point grounding schemes. Give the merits and demerits of each grounding system.

[8 marks]

(b) The Thevenin of equivalent circuit of a load with the load current, I_L connected to the end of a power distribution bus is shown in Figure Q2b. The decoupling capacitor, C_d is used to prevent load voltage, V_L, from decreasing below the minimum acceptable supply voltage, V_s. The length of the bus is 30 cm and the propagation velocity is 40% of the speed of light. Assuming the characteristic impedance, Z_o is 50 ohm, and transient current, I_T is a step function that equals to 20 mA.

(i) Find the maximum change in V_L for $C_d = 0.01$ μF and $C_d = 0$.

[6 marks]

(ii) What is the required value for C_d in order to limit the change in V_L to 0.02 V?

[3 marks]

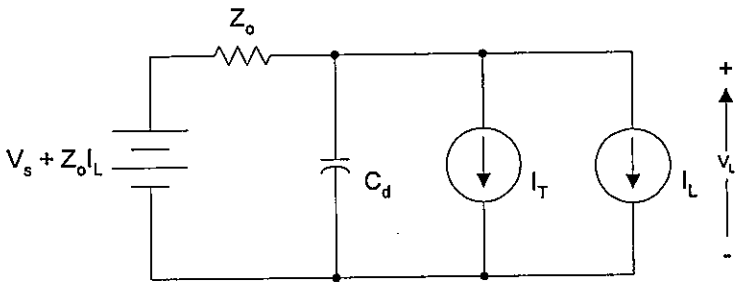

Fig. Q2b

(c) Electrostatic Discharge (ESD) can be a major cause of EMI.

(i) State FOUR (4) ESD coupling mechanism in electronics circuits.

[4 marks]

(ii) State FOUR (4) precautions that need to be taken in electronics system to avoid or mitigate ESD occurrences.

[4 marks]

Continued . . .

Question 3

(a) Identify THREE (3) main factors which determines the overall shielding effectiveness of a shielding material.

[3 marks]

(b) Suggest THREE (3) steps that can minimize radiation due to electric dipole.

[6 marks]

(c) The expressions for electric-fields and magnetic-fields of a small current loop of area A in the x-y plane and excited by a time varying current $I_o e^{j\omega t}$ is given by:

$$H_S = \frac{jkI_oA}{4\pi}\left[2\left(\frac{1}{r^2}+\frac{1}{jkr^3}\right)\cos\theta\ \hat{a}_r + \left(\frac{jk}{r}+\frac{1}{r^2}+\frac{1}{jkr^3}\right)\sin\theta\ \hat{a}_\theta\right]e^{-jkr}$$

$$E_S = -\eta\frac{jkI_oA}{4\pi}\left[\left(\frac{jk}{r}+\frac{1}{r^2}\right)\sin\theta\ \hat{a}_\phi\right]e^{-jkr}$$

where η = intrinsic wave impedance, I_0 = current amplitude, k = phase constant
r = distant from the source, l = length of dipole

For near-field and far-field regions,

(i) Derive the simplified equations for the electric-fields and magnetic fields.

[6 + 6 marks]

(ii) Deduce the wave impedance at both regions.

[4 marks]

Continued . . .

Question 4

(a) Explain why it is necessary to set international standards for Electromagnetic Compatibility (EMC).

[4 marks]

(b) Name the EMC standard making bodies for each of the following: International and European.

[4 marks]

(c) The FCC radiated emission limits for Class-A and Class-B digital devices are shown in Table Q4c. A product is to be tested for FCC Class-B radiated emissions at 10 meter range. A Bilog antenna is connected to the spectrum analyzer through a 10 meter coaxial cable. The cable loss and antenna factor at 200MHz are 0.3dB/m and 3.1dB, respectively. If the spectrum analyzer measured a level of 30 dBμV at 200MHz.

Table Q4c: FCC Radiated Emission Limits

Frequency	Class-B limits (3m)	Class-B limits (10m)
30 – 88 MHz	100 μV/m	30 μV/m
88 – 216 MHz	150 μV/m	45 μV/m
216 – 960 MHz	200 μV/m	60 μV/m
Above 960 MHz	500 μV/m	150 μV/m

(i) Calculate the received electric field at the antenna in μV/m and dBμV/m.

[6 marks]

(ii) Determine whether the product passes or fails the FCC Class-B test and by how many dB.

[4 marks]

(d) Explain the purpose of having the absorbers in the shielded chamber. What would be effect if the absorbers are absent?

[7 marks]

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